

CHAPTER 11

DAMS



Overview

Dams are an important feature of the New Hampshire environment, creating some of the best water-based recreational areas in the state, providing water supply and hydropower, and, in a few cases, flood control. Some historic dams are closely tied to people's sense of community character and aesthetics. During droughts dams can be important in retaining water for water supply and industrial use. On the other hand, dams can block fish migrations and adversely impact downstream water quality and streamflows. Also, dams that are not maintained in good operational order can fail and cause loss of life and economic damage. In New Hampshire the risks associated with many dams are increasing rapidly because of: 1) the encroachment of businesses and homes downstream from dams in areas that would be flooded if the dams were to fail; 2) increasingly frequent extreme rainfall events due to climate change, as explained in Chapter 1 – Introduction and Overview; and 3) a lack of important maintenance on many privately owned and some publicly owned dams.

11.1 Description and Significance

11.1.1 Dam Classifications

There are 3,070 active dams in the state of New Hampshire. Eight hundred forty of these are classified as “hazardous” because the flooding produced by their failure would result in loss of life or property damage downstream. The remaining 2,230 active dams are classified as “non-hazardous.” The hazardous classification of dams is based on the extent of development downstream within the potentially inundated area and is not related to the condition of the dam. Many dams in New Hampshire are small: 35 percent are less than 8 feet high. Almost 50 percent have less than 50 acre-feet of storage (New Hampshire Department of Environmental Services [NHDES], 2008).¹ The largest dam in New Hampshire is the Moore Reservoir dam on the Connecticut River in Littleton

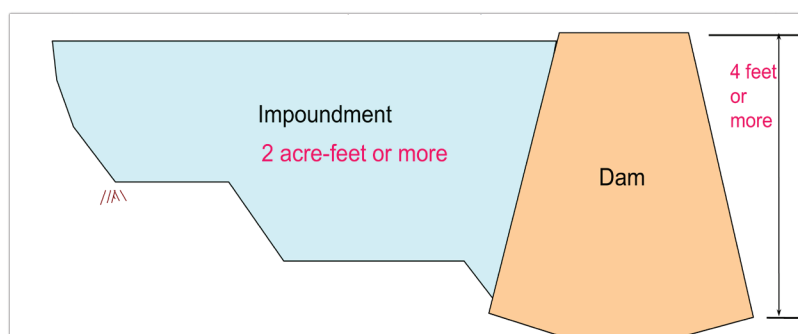


Figure 11-1. Diagram of New Hampshire's definition of a dam. See “Statutory Definition of a Dam” (next page) for additional information. Source: NHDES, 2006.

at 193 feet high and 2,920 feet long. This dam holds the largest conventional hydropower station in New England with a capacity of generating 192 megawatts (Connecticut River Joint Commissions, 2008).

Hazardous Dams

There are 90 dams in New Hampshire that are currently classified as High Hazard Dams because

¹ One acre-foot of water is about 325,851 gallons or one foot of water covering an area of one acre.

Statutory Definition of a Dam

II.(a) "Dam" means any artificial barrier, including appurtenant works, which impounds or diverts water, and which has a height of 4 feet or more, or a storage capacity of 2 acre-feet or more, or is located at the outlet of a great pond. A roadway culvert shall not be considered a dam if its invert is at the natural bed of the water course, it has adequate discharge capacity, and it does not impound water under normal circumstances. Artificial barriers which create surface impoundments for liquid industrial or liquid commercial wastes, septage, or sewage, regardless of height or storage capacity, shall be considered dams.

(b) An artificial barrier at a storm water detention basin, which impounds 0.5 acre-foot or less of water during normal conditions, shall not be considered a dam unless its height is 10 feet or greater or its maximum storage is 6 acre-feet or greater. (RSA 482:2, effective August 18, 2006). See also Figure 11-1.

their failure would inundate homes or other occupied structures downstream and likely cause loss of life. Another 192 are classified as Significant Hazard Dams because their failure would cause major property damage downstream, and 558 are classified as Low Hazard Dams because their failure would cause minor property damage downstream, such as damage to a town road. The New Hampshire Department of Environmental Services estimates that there are more than 10,000 homes, 500 state road crossings, and more than 4,500 town road crossings that would be destroyed or damaged if these hazardous dams were to fail (NHDES, 2008).

11.1.2 Dam Ownership

The breakdown of all dams by type of owner is shown on the pie chart in Figure 11-2. Governmental organizations or utilities own about one-quarter of the dams in the state. Utilities own 12 dams, various municipalities own 389, the federal government owns 38, and the state of New Hampshire, through its various state agencies, owns 273. However, the vast majority of the dams, 2,358, are owned by private organizations or individuals.

The privately-owned Meadow Pond Dam in Alton was a Significant Hazard Dam that failed in 1996 (Figure 11-3). It caused approximately \$8 million worth of property damage and one fatality when the State Route 140 road crossing downstream was destroyed. Using the costs of this tragedy as a benchmark, it is clear that many thousands of lives and hundreds of millions of dollars of property are at risk downstream of dams. Recent events in Alstead dramatically illustrate the destructive force

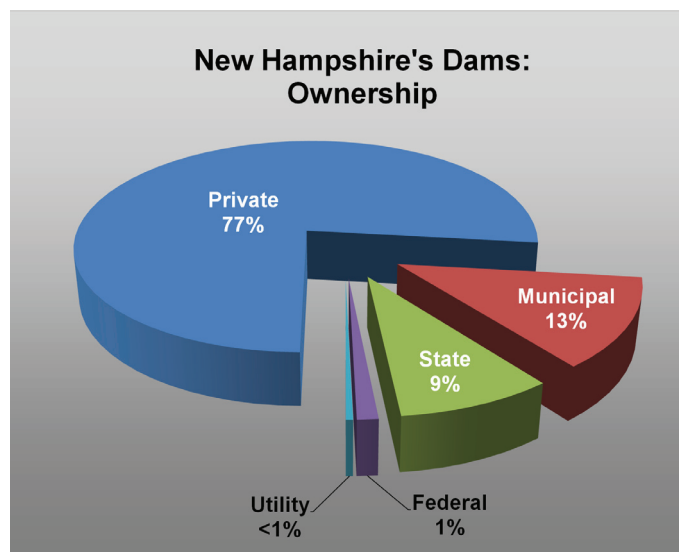


Figure 11-2. Dam ownership percentages in New Hampshire. Source: NHDES, 2008.

of a sudden release of stored water. There, a roadway embankment was overtopped and failed causing loss of life and enormous devastation downstream.

11.1.3 Benefits and Purposes of Dams

Most dams in New Hampshire were originally built for recreation (1,448), or conservation/ farm ponds (759 – includes small ponds for wildlife and other miscellaneous purposes). Others have been built for stormwater detention (295), fire ponds (239), hydropower (132), sewage treatment (60), water supply storage (76), flood control (45) and mill process water (16) (NHDES, 2008). A pie chart depicting the breakdown of the number of dams by use is shown in Figure 11-4.



Figure 11-3. Meadow Pond Dam in Alton looking downstream at road damage. One life was lost when the dam failed. Source: NHDES, Dam Bureau File Photo.

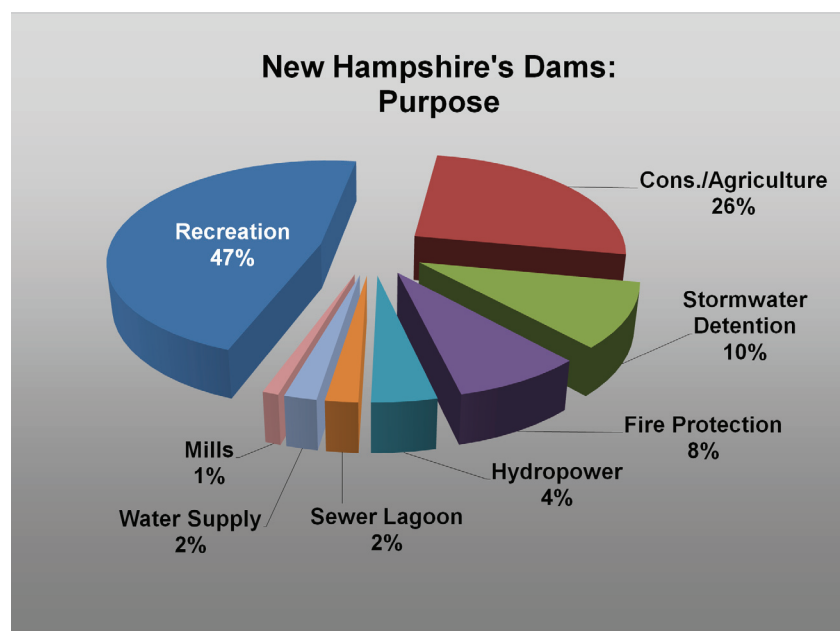


Figure 11-4. As shown in the figure, the single largest purpose of New Hampshire dams is recreation, of which there are 1,448. Dams that impound conservation or farm ponds make up the next largest category with 759, followed by stormwater detention ponds (295), fire ponds (239), hydropower dams (132), sewage lagoons (60), water supply reservoirs (76), flood control dams (45) and mill dams (16). Source: NHDES, 2008.

Recreation

In many places where dams provide for the enlargement of existing water bodies, they have created the largest and most important recreational lakes in the state, including Winnepesaukee, Squam, Winnisquam, Newfound, Sunapee and Ossipee. The impoundments behind dams provide habitat for waterfowl, wildlife, fish and other aquatic species, as well as recreation opportunities for boaters, anglers, hunters and bird watchers.

Economic Benefits

According to the New Hampshire Lake Association's Report on the Economic Value of New Hampshire's Surface Waters, New Hampshire's

lakes provide up to \$1.5 billion annually of economic benefit to the state, and waterfront property owners pay nearly a quarter billion dollars annually in property taxes (Nordstrom, 2007). Since the majority of New Hampshire's surface waters are impounded by dams, the upkeep of these dams is important, not only to protect public safety and the environment, but also to maintain the significant economic benefits that they provide.

Industrial and Community Benefit

Dams have a variety of benefits to New Hampshire's businesses and communities, including water supply storage, hydropower generation, fire ponds, stormwater or sewage detention, mill process water, and farm ponds. These encompass about 50 percent of the total number of dams in the state, most of them rather small.

Flood Control

Although dams are inherently associated with flooding, a common misconception is that most dams reduce flooding. In fact, most create flooding risks that are greater than they would be without the dam present. Only 45 (less than two percent of the total number) of New Hampshire's dams were built primarily for flood control (NHDES, 2008).

11.2 Issues

11.2.1 Dam Failures and the Increased Risk from Downstream Development, Climate Change, and Lack of Dam Maintenance

Why Dams Fail

Although the majority of dams in New Hampshire have responsible owners and are properly maintained, dams can and do fail, particularly when they are stressed by high flows such as those that have occurred during the three major floods that New Hampshire experienced in 2007 and 2008. Dam failures are most likely to happen for one of five reasons:

- Overtopping (water spilling over the top of a dam).
- Structural failure of materials used in dam construction.
- Cracking caused by movements such as the natural settling of a dam.
- Inadequate maintenance and upkeep.
- Piping: when seepage through a dam is not properly filtered and soil particles continue to progress and form sink holes in the dam.

Historically dams that failed had some deficiency, as characterized above, which caused the failure. These dams are typically termed "deficient." Currently, DES records indicate that there are about 155 deficient dams in New Hampshire (NHDES, 2008).

Expanding development downstream, not new dam construction, is increasing the number of High Hazard Dams, and the state has little control over it.

There Are an Increasing Number of High Hazard Dams

The number of high-hazard structures is increasing, not because more high-hazard dams are being built, but because there is more encroachment on areas that would be inundated should a dam fail. The state has no control over land use within the area downstream of dams that could potentially be inundated from a dam failure. Local control through floodplain zoning and other mechanisms is possible, but many communities have not adopted these mechanisms.

Extreme Events Are Increasing the Likelihood of Failures

Landscape change associated with development and higher frequencies of extreme precipitation events, explained in Chapter 1 – Introduction and Overview, both put greater pressures on existing dams. Continuing increases in watershed imperviousness escalate the percentage of precipitation that runs off the land, boosting the frequency and magnitude of high stream flows. Climate change is also predicted to increase the intensity and frequency of high-runoff events (Madsen & Figdor, 2007), compounding the pressure on dams.

New Hampshire Ranks Third in the Country in Numbers of Known Dam Deficiencies

Problems with dams are not peculiar to New Hampshire. According to the American Society of Civil Engineers (ASCE) 2005 Infrastructure Report Card, “The combined effect of rapid downstream development, aging/non-compliant structures and inadequate past design practices, coupled with a predicted increase in extreme events, demands fully funded and staffed state dam safety programs, as well as substantial and proactive funding for (private) dam repairs” (ASCE, 2005).

Dams must be maintained to keep them safe. Occasional upgrade or rehabilitation is necessary due to deterioration, changing technical standards, improved construction techniques, better understanding of the area’s precipitation conditions, increases in downstream populations, and changing land use. When a dam’s hazard classification is changed to reflect an increased hazard potential, the dam may need to be upgraded to meet an increased need for safety.

The lack of funding for dam upgrades has become a serious concern, especially within the private sector. Unfortunately, operation, maintenance and rehabilitation of dams can range in cost from the low thousands to millions of dollars, and owners are responsible for these expenses. In New Hampshire more than three-quarters of the dams are privately owned and many owners cannot afford these costs.

The DES Dam Bureau regularly inspects, on a schedule based on hazard classification, the 840 hazardous dams. Following those inspections, DES issues reports to the dam owners identifying the deficiencies observed during the inspection and specifying a schedule to correct the deficiencies. However, compliance inspections and follow-up on deficient dams currently lag performance goals. At this time, there are 155 dams with known deficiencies of some form, including six with major deficiencies (NHDES, 2008). This ranks New Hampshire third in the country in the number of dams with identified deficiencies (Association of State Dam Safety Officials, 2007).

The Program for the Maintenance of State Owned Dams Has Become Insolvent

The DES Dam Bureau is charged with repairing and reconstructing all 273 state-owned dams. Financing these repairs and reconstruction is as much of a problem for the state as it is for private owners.

The state Dam Maintenance Fund is supposed to support the operation, maintenance, repair and reconstruction costs for state owned dams. However, the sole source of revenue to the fund is rent payments that DES receives from leasing 12 of the dams that it owns to private hydropower developers to generate electricity at the sites. Under the terms of the leases, the rent that is paid to DES is a percentage of the revenue from the sale of power at the facilities. Eleven of these lessees sell the power to Public Service of New Hampshire (PSNH). In 2002 PSNH initiated actions to renegotiate their above-market power purchase agreements with the small power producers from whom they purchase power. The result was a 40 percent drop in revenue to the state Dam Maintenance Fund, which, combined with the continuing obligations of the fund, has caused the fund to become insolvent.

11.2.2 Dams Can Have a Negative Ecological Impact

Although well-maintained dams can provide many benefits, they can also cause a number of environmental problems, including blockage of fish passage, interruption of sediment and nutrient transport, changes in temperature and chemical constituents, interference with the reproduction of aquatic life, and fragmentation of natural habitats. The effects can be felt significantly downstream and can modify, sometimes dramatically, the operation of a dam. For example, flows have changed significantly in the Lamprey River when the management of the Dolloff dam in Nottingham was changed in 1955 and also when leakage was repaired (see Figure 11-5).

As water is detained behind larger dams, sediments tend to settle to the bottom behind the dam, building up in layers. This factor may actually improve the water quality in ponds downstream of a series of dams, but the riverine characteristics of habitat and fisheries are lost. Water temperatures are usually higher and oxygen levels lower because of a dam. Fish passage both up and downstream may be entirely lost. The sediment built up behind a dam may lead to increased oxygen consumption and create internal cycling of nutrients that can lead to algal blooms. Algal blooms can result in fish kills and threats to human health.

Downstream of the dam there can be significant negative effects. Flow may be significantly reduced, stranding aquatic life and cutting off usable habitat upstream. Anadromous fish that swim upstream may be prevented from migration, and most fish ladders, where they exist, are far from perfect.

11.2.3 Lack of Awareness of Dam Hazards and Problems

As described previously in this chapter, the interruption of streams by dams impacts water quality, flows, and habitat of fish and other aquatic life. In addition, there is a general lack of awareness of these issues and the risks of dams failing.

The ordinary citizen is unaware that the beautiful lakes on which he or she boats, skis or fishes are only there because of man-made dams. Often they are equally unaware of the higher quality fisheries and recreational opportunities that might be there without the dam.

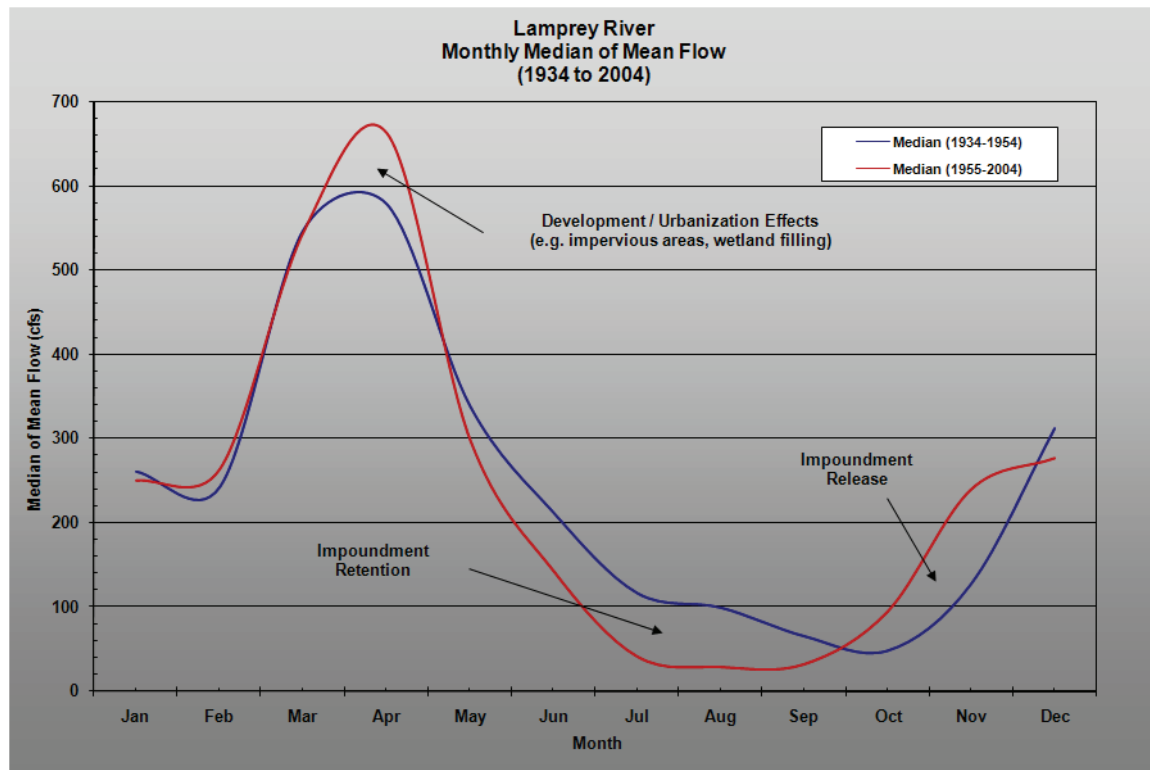


Figure 11-5. Flows in the Lamprey River have been significantly affected over the years by the construction of dams and changes in their operation. Data Source: U.S. Geological Survey, 2005.

Owners of homes or commercial interests that have built in areas that could be inundated from a dam failure flood typically know little about the potential devastation that an upstream dam could cause should it fail. Even if people are aware of dams, they still have unrealistic expectations of the ability of the dams to reduce flooding downstream. Many dam owners do not realize their responsibility and liability toward the downstream public and environment. Adequate understanding of proper dam maintenance and upgrade techniques is a typical problem among many owners.

11.3 Current Management and Protection

11.3.1 Ongoing and Recently Passed Legislation

Increased Fees to Support Inspection

During the 2006 legislative session, the New Hampshire Legislature passed HB 664, which increases the fees charged for a permit to construct or reconstruct a dam as well as the annual dam registration fees. In addition to covering the costs of inspection and permitting, the resources provided with these fee increases will allow DES to increase follow-up inspections and institute enforcement actions, where necessary, to reduce the number of non-compliant dams by 75 percent.

Study Committee on Funding Alternatives

Since 2004 the New Hampshire Legislature has been working to identify a new source of funding for the operation, maintenance and repair of state-owned dams. In 2004 the Legislature formed a committee to study funding alternatives.

The committee's final report predicted that the shortfall in the Dam Maintenance Fund could be over \$1 million per year in the short-term and average \$900,000 per year over the next nine years (Committee, 2004). The committee concluded that since the dams could not be dismantled or turned over to others, another source of funding needed to be found to fill this gap. Two sources that were examined by the committee, but were determined to be impractical, included: 1) leasing additional dams for hydropower generation; and 2) increasing fees derived from fishing licenses, boat registrations, boat moorings and state parks.

The committee then focused on those who benefit most directly from the impoundments created by state-owned dams, namely, shorefront property owners. One possible solution would be to assess them a fee of per linear foot of shorefront property.

Another recommendation by the committee was to allocate a portion of the unrefunded road toll taxes to the Dam Maintenance Fund. Bills introduced in the Legislature to implement each alternative failed to pass, but the House Ways and Means Committee is currently examining the issue with possible legislation to be introduced in the 2009 session.

Comprehensive Flood Management Study Commission

This commission, created by House Bill 648 in 2007, was charged with studying possible measures for controlling floods to minimize their impact on communities and individual properties. The scope of the commission's work included land use management to reduce flood runoff, flood hazard assessment, evaluation of dams and reservoirs, implementing possible zoning and flood-plain regulations, cooperative efforts between private dam owners and the New Hampshire Office of Emergency Management in the event of serious flood threats, and flood forecasting practices. The commission issued its report in September 2008 (Comprehensive Flood Management Study Commission, 2008); more information can be found in Chapter 12 – Floods and Droughts.

Dam Removal and River Restoration Programs

In January 2000 the New Hampshire River Restoration Task Force was formed with the goal of exploring opportunities to selectively remove dams for a variety of reasons, most notably for the purposes of restoring rivers and eliminating public safety hazards. The task force is an initiative with diverse representation, including multiple state and federal agencies, conservation organizations, local interests and others. Through its work the task force is enabling an efficient and effective process of removing dams in New Hampshire. Due to the collaborative efforts of the task force, two dams have been removed from the Ashuelot River for the purpose of river restoration: the McGoldrick Dam in Hinsdale in 2001 and the Winchester Dam in 2002. These dam removals are critical pieces of a basin-wide plan to restore anadromous fish to the Ashuelot River, a historically significant Connecticut River tributary for American shad, blueback herring and Atlantic salmon. Several additional dam removals statewide are currently in the planning and permitting stages.

11.3.2 DES Programs

Dam Inspection and Repair Program

As previously described, DES's Dam Bureau inspects the 840 dams that could cause loss of life or property damage downstream, but the follow-up lags performance goals due to staffing. There are 155 dams with known deficiencies at present, with six that have major deficiencies.

Dam Permitting Program

New dams and the reconstruction of existing dams require a permit from DES through both the Dam Bureau and the Wetlands Bureau. Each dam is classified as to hazard potential and the owner must prepare an Emergency Action Plan for all dams that may be a menace to public safety due to their condition, height and location. The Emergency Action Plan is a document establishing: 1) a notification plan; 2) information on the potential extent of downstream flooding; and 3) pre-planned emergency actions to be taken upon indication of an impending dam failure or unsafe condition.

Alteration of Terrain Program

The Alteration of Terrain rules (Env-Ws 415) cover land disturbances that exceed 100,000 square feet. The cumulative effects of increasing development on peak flows and flows during small storm events will be minimized through Alteration of Terrain rule changes taking effect on January 1, 2009. The rule changes require infiltration of stormwater, helping to minimize the hydrologic impacts of new development.

Wetlands Permitting

Wetlands play an important role in moderating the flow of runoff and, consequently, the stress placed on dams. The Wetlands Bureau within the Water Division of DES regulates activities in wetlands in New Hampshire. More information on wetlands issues can be found in Chapter 5 – Wetlands.

11.3.3 Non-DES Programs

National Flood Insurance Program (Floodplain Management)

The National Flood Insurance Act of 1968 established the National Flood Insurance Program (NFIP). The NFIP enables property owners in participating communities to purchase insurance as a protection against flood losses in exchange for state and community floodplain management regulations that reduce future flood damages. People can only participate if their community has established the required floodplain regulations and participates in the program. This insurance is designed to provide an insurance alternative to disaster assistance to reduce the escalating costs of repairing damage to buildings and their contents caused by floods (NFIP, 2002).

Federal H.R. 3224 the Dam Rehabilitation and Repair Act

H.R. 3224, which was introduced in the 110th Congress, would have provided funding for the repair of publicly-owned dams (H.R. 3224, 2007). Under the allocation formula in the bill, New Hampshire would have received approximately \$2.5 million over a five-year period for the repair

of publicly-owned dams. The bill, which was co-sponsored by both representatives from New Hampshire, passed the House in 2007 but died in the Senate and is expected to be reintroduced in 2009.

11.4 Stakeholder Recommendations

11.4.1 Improve Dam Maintenance

Dams must be maintained to keep them safe. The lack of funding for dam maintenance and upgrades has become a serious concern, within both the private and public sectors. The funding needs for the repair of both publicly and privately owned dams must be addressed to ensure that the state's dams continue to be operated and maintained so that they do not pose a threat to life and property downstream and continue to provide economic and recreation benefits to the state. While some initial progress is being made on the state and federal levels to fund the operation and maintenance of publicly owned dams, unsafe privately owned dams can also cause loss of life and severe economic damage to private property and public infrastructure.

As previously stated, the state Dam Maintenance Fund is insolvent. Another source of funding is needed to make up the shortfall created by the 40 percent reduction in lease payments on state-owned hydro dams. Establishment of a dependable funding source for the operation, maintenance and repair of state-owned dams is now critical. One way to address the shortfall would be to establish a low interest loan program in New Hampshire, similar to those developed in other states, to finance the repair and upgrade of both publicly and privately-owned dams.

11.4.2 Remove Unnecessary Dams

Because of the negative ecological impacts caused by dams and the high cost of maintenance, private dam owners should be further encouraged to remove unneeded dams, especially those that are old or in disrepair. The N.H. River Restoration Task Force should facilitate these dam removals through technical assistance, identification of funding sources, and streamlining of dam removal permits.

11.4.3 Increase Public Awareness

There needs to be improved outreach to increase public awareness about the benefits, risks and ecological impacts associated with New Hampshire's dams.

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